NASA NICE-T GCCE Project 2014

“Weathering Change”

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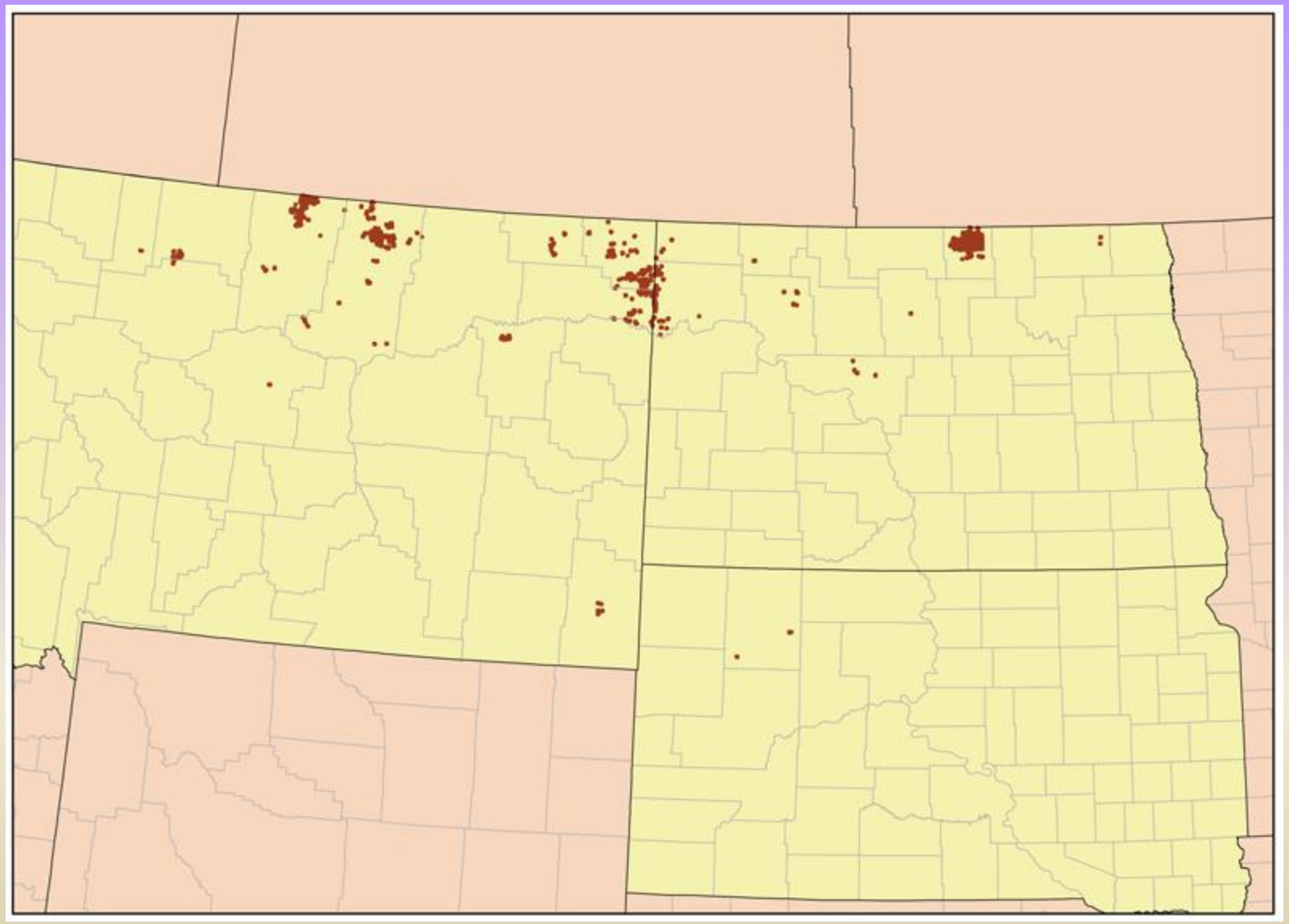
Profile of Turtle Mountain Chippewa Reservation

One of the smallest reservations in U.S. at 6 x 12 miles in area

Situated in Rolette County, with a population of ca. 10,000 Native Americans and 3000 non-Natives

The final remnant of previous land, the reservation is on glacial hills with many lakes and sloughs, with some ranching but very little crop farming



Turtle Mountain Chippewa Reservation and Trust Lands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Anishinabe Wellness Center

General Goals of the 2014 NASA NICE-T Project

- Presentation of NASA mission and NASA datasets to college undergraduates, teacher candidates and teachers.

- An increased knowledge base of STEM principles, applications and laboratory skills for the same target audience, with emphasis on GCC tie-ins.

More Specific Goals…

- Presentation of global climate change concepts, research and datasets with emphasis on ease of use by teachers.

- Expansion of the workshop format to include power-points, assessment tools, laboratories and lesson plans for use by participants in their own teaching.

Objectives of the Project

- Training: The successful completion of eight workshops (16 days, 6 hours per day) by at least 15 education students, faculty, or STEM students per summer. Attendance, 16 computer worksheets/quizzes and 16 laboratories will serve as criteria for completion.

- Materials: All instructional materials (power points, computer activities, datasets and tutorials, laboratories and lesson plans) will be provided to all participants via jump drive (paperless) and online course.

- College credit: Education students will earn four credits for a special topics laboratory course. A course for local HS and ES faculty is being worked on.

- Retention of developed instructional materials by TMCC faculty for use in general education courses- biology and physical sciences.

- Evaluation and technical assistance- external critique by independent assessor as well as input by university NASA affiliates for improvement of the program

Workshop Approach

- Workshops are conducted by all TMCC co-investigators, alternating between STEM background presentations and laboratory, GCC presentations and datasets/tutorials, and educational applications
- GCC information presented by co-PIs as Power Points as well as NASA datasets/tutorials and laboratories (or in Word format)
- All materials accessed through Jenzabar, TMCC course software- all laboratories and computer activities answers filed with instructors
- Adaptations of materials to different grade levels discussed
- Reference to indigenous peoples and climate change effects made in various modules
- Co-PIs lead participants through various NASA datasets and tutorials; also display animations and videos. Other agency information also presented: USGS, NOAA, NCAR and others.

Workshop Topics

- Introduction to NASA and remote sensing
- Energy, Economy and Climate
- Ice and Remote Sensing
- Weather and Local Effects
- Deforestation, Desertification and Sedimentation
- Climate Calamities- Flood, Drought and Fire
- Seismic Activity and Climate
- Chemical Detection in Air and Water/GIS introduction

Introduction to NASA and Remote Sensing

Concepts/ laboratories:

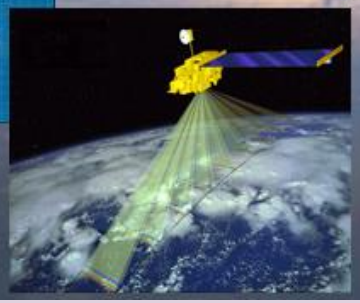
- Introduction and history of NASA and remote sensing satellites
- Introduction to EM spectrum, image analysis (RGB) and land use patterns
- Principles of reflectivity, emissivity, colorimetry
- Computer exercises in land use, image interpretation
- Introduction or review of STEM principles of measurement (volume, length, concentration, energy)

<u>NASA datasets and application</u>:
A general overview of what NASA "does," including image data gathering by remote sensing, satellite and technology innovation, and measurement of climate and pollution parameters

Careers in STEM and at NASA; spectrum of career choices, training and education requirements

Introduction to NASA PP

Aqua Satellite, launched in 2002, collecting data on Earth's oceans as well as information on the hydrologic cycle: water vapor, precipitation, soil moisture, sea ice, radiative energy and aerosols, as well as other applications including vegetation monitoring on land.
The Terra Satellite, launched in 1999, was primarily intended to observe climate and climate change. Both are part of NASA's Earth Observing System (EOS). There are several specialized instruments aboard both satellites. Other satellites with similar missions include Aura, PARASOL, CALIPSO, CloudSat and OCO-2.



Terra Instruments:

ASTER, or Advanced Spaceborne Thermal Emission and Reflection Radiometer
CERES, or Clouds and Earth's Radiant Energy System
MISR, or Multi-angle Imaging Spectroradiometer
MODIS, or Moderate-resolution Imaging Spectroradiometer
MOPITT, or Measurements of Pollution in the Troposphere

Careers at NASA

- NASA, like other STEM-based institutions, may have a workforce deficit over the next several decades due to retirement of senior scientists and low college STEM turnout
- The breakdown of career categories:
  Scientific, engineering or other professional- 60%
  Administrative, Management- 24%
  Clinical and Administrative Support- 7%
  Technical and Medical Support- 9%
  Trades and labor - < 1%

NASA Workforce Map

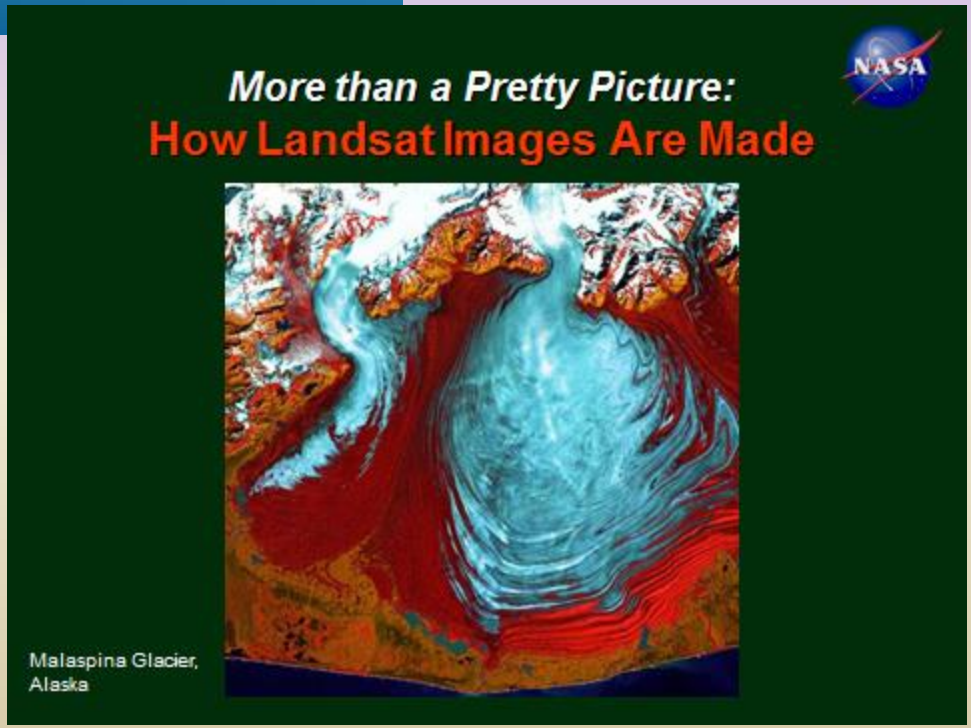
http://nasajobs.nasa.gov/careers_lp.htm

Online Tutorials:

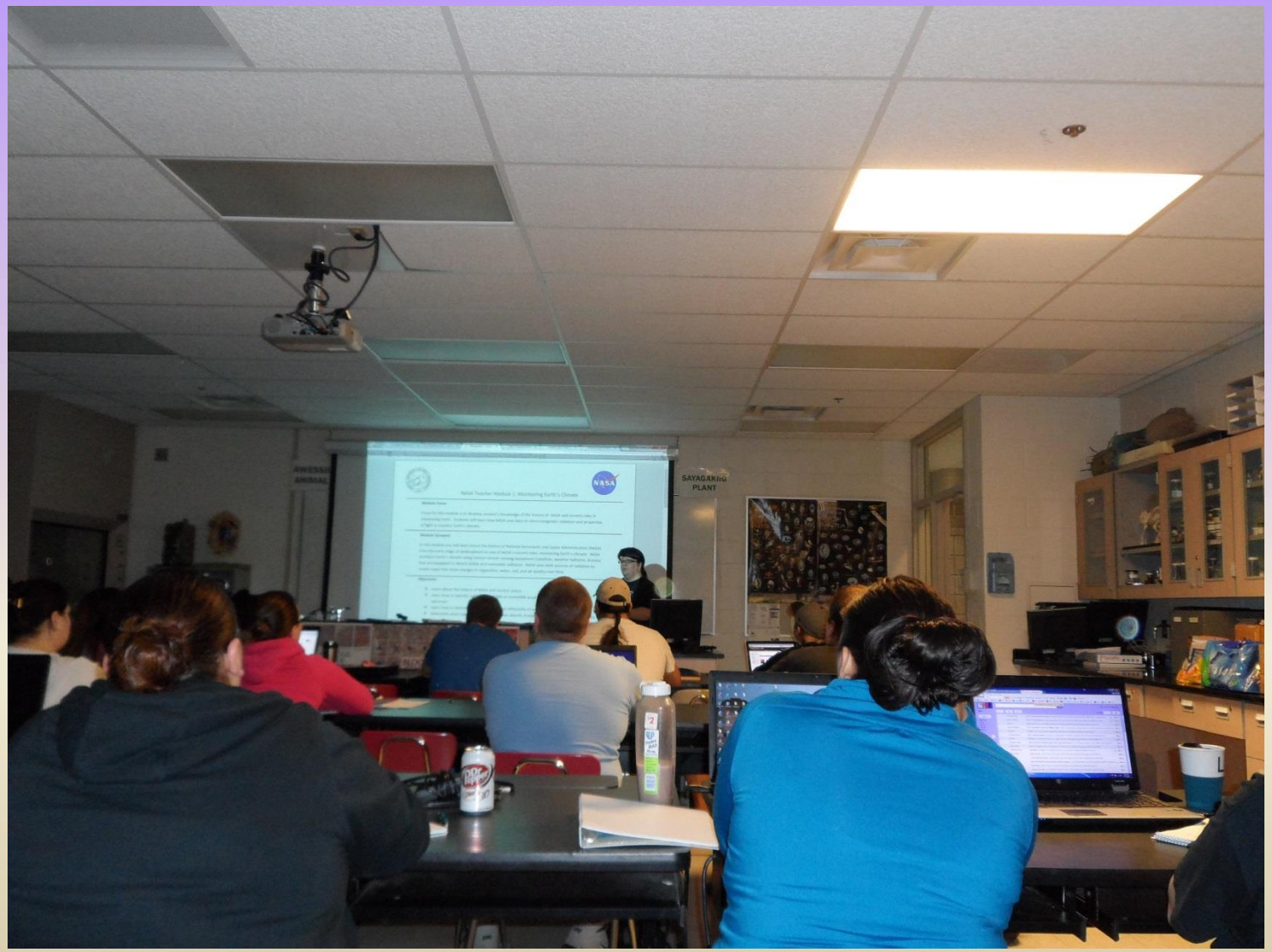
- Spacecraft and Instruments
  http://landsat.gsfc.nasa.gov/?page_id=4094
- LandSat – more than a pretty picture- (tutorial)
  http://landsat.gsfc.nasa.gov/?p=5139
- Also LandSat LookViewer at same site: Zoom in to an area and view between 1999 and 2014.

Datasets and Tutorials
Examples

Labs:
1. Assign RGB status to maps
2. ID of earth features in satellite imagery




NYC


NASA
SAYAGAKIHO
PLANT

Energy, Economy and Climate

- Fossil fuel major reserves (oil, coal, natural gas), major exporters and importers
- Electrical power plant process, synfuel process
- Working concepts and usage of alternative energy forms (solar, wind, geo)
- CO_2 statistics, strategies for mitigation
- Environmental collateral damage: fracking, incomplete combustion products
- Tribal conflicts

Laboratory activities:

- Energy content of various fuel sources
- Calculating energy production from energy models- comparison of reality and theory

NASA datasets and application:

Visible earth- smog, flaring, spills

JPL- CO_2 levels data

Climate change effects overview (trends in ice melt, wildfire, aerosol, ocean current change

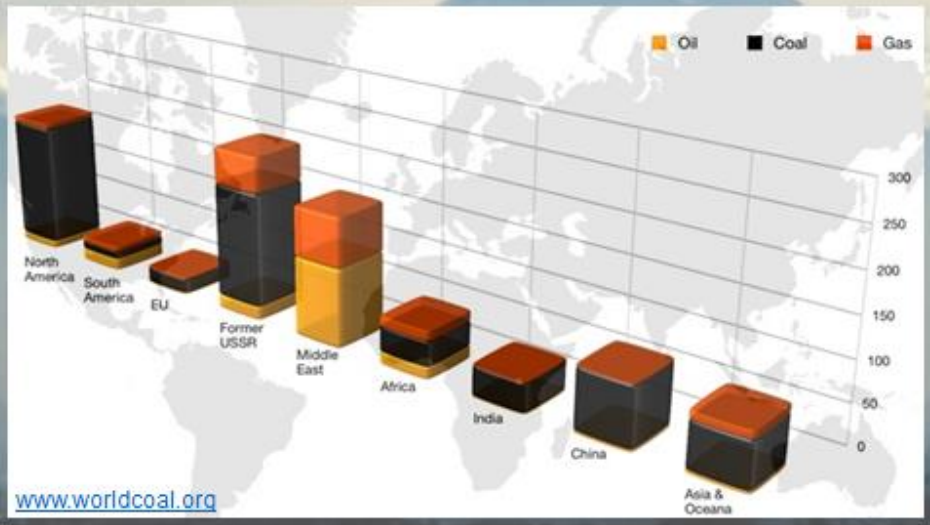
CO_2 and Global Energy PP

CO_2 Production in U.S. (from human activity)

CO_2 production in 2012 was 5250 million metric tons, up 5% from 1990

- Electricity generation 38%
- Transportation 32%
- Industry (fossil fuel combustion) 14%
- residential and commercial 9%
- Non fossil fuel combustion 6% (cement, steel, chemical production)

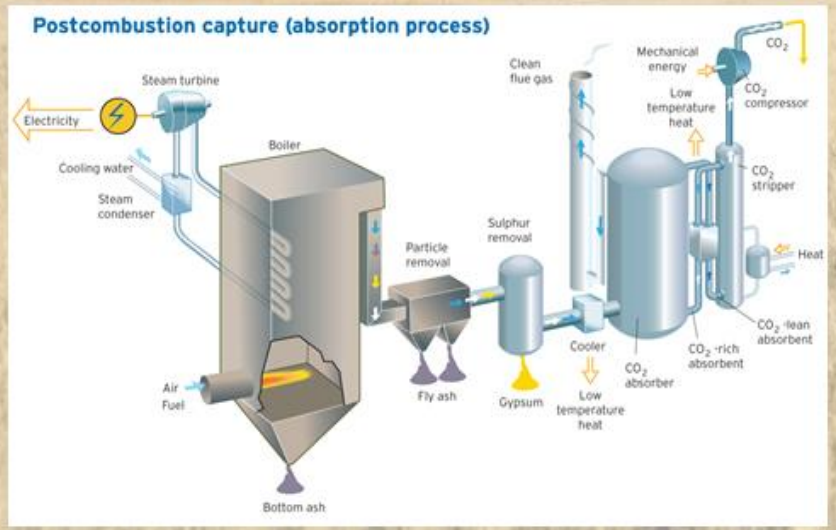
Reserves and Owners in 2010



U.S. and ND Energy PP

Focus on Electrical Plants

- Amine scrubbing technology is known- can be improved to remove 80% to 90% of CO_2 but will increase costs by 20-90%
- Carbon is taken from a power plant source in three basic ways – post-combustion, precombustion and oxy-fuel combustion.
  - post: a solvent dissolves the gas, and is heated to separate CO_2- and is costlier, but can be used to retrofit
  - pre: CO_2 combined with amines, later separated by weight- will cost less, and concentrate CO_2 more efficiently
  - oxy-fuel: Fuel burned in O_2 to produce only water and CO_2- CO_2 separated by cooling and compressing



Millicentmedia.com

Environmental Concerns and Technology PP

FLARING FACTS

- More than one-third of the natural gas produced in the Bakken is flared (US Energy Information Administration)
- North Dakota flared an amount of natural gas in 2011 that had an estimated market value of roughly $110 million
- The "unmarketable" natural gas cannot be transported easily and the area lacks sufficient infrastructure to collect, process and move the gas
- 4.5 MMT of CO_2 added to air from flaring in the Bakken in 2012

http://blog.trcsolutions.com/bakken-flaring/

Publiclab.org

Datasets Examples

Interesting movie clip on global flares: http://ngdc.noaa.gov/eog/interest/gas_flares.html

http://ngdc.noaa.gov/eog/interest/gas_flares.html

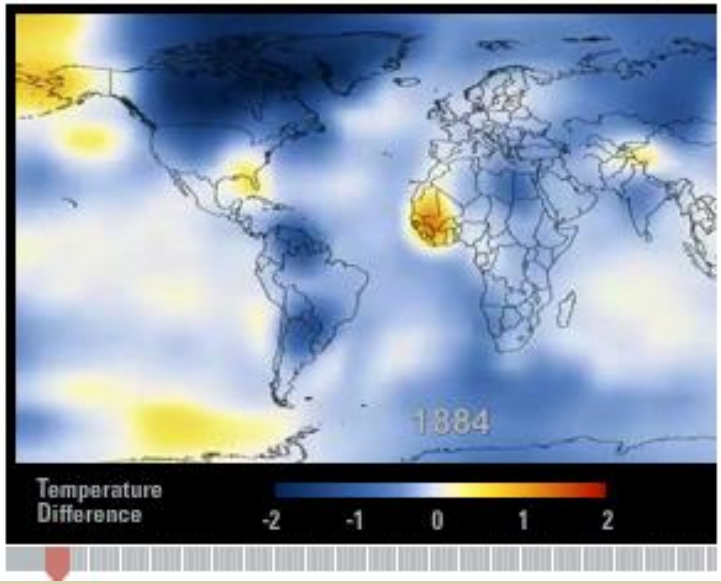
Google earth based app showing location of gas flaring by NOAA observations; Russia KM shown offender.

TIME SERIES: 1884-2012

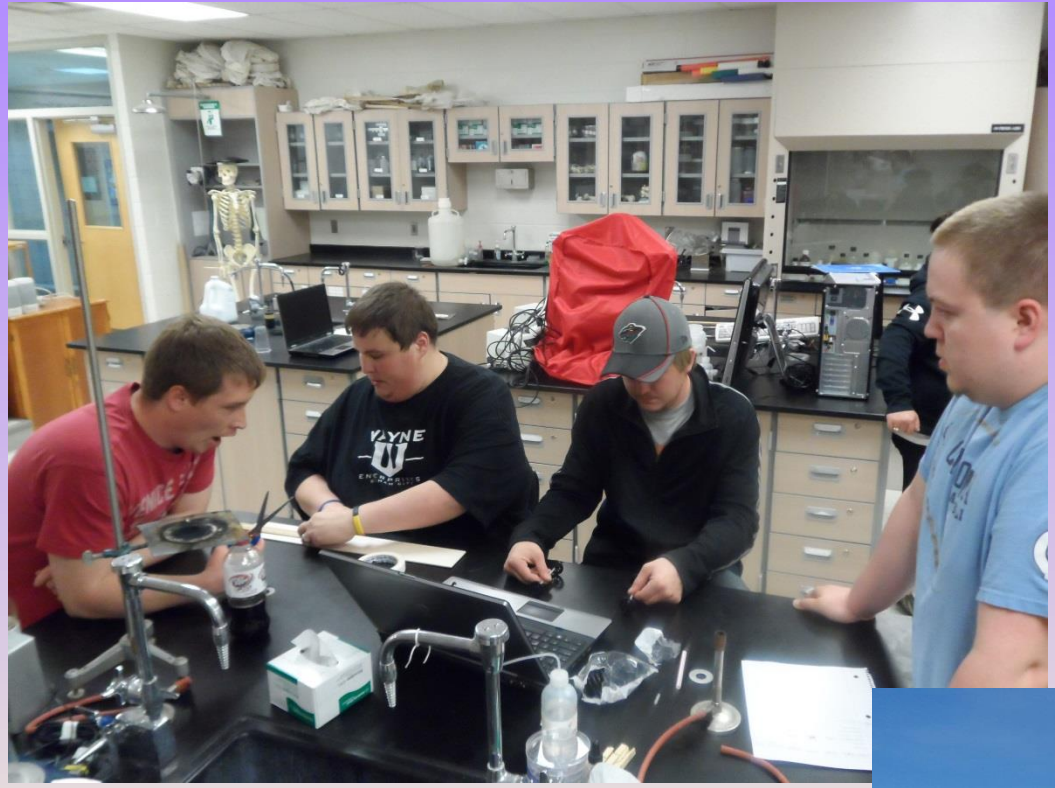
Data source: NASA/GISS

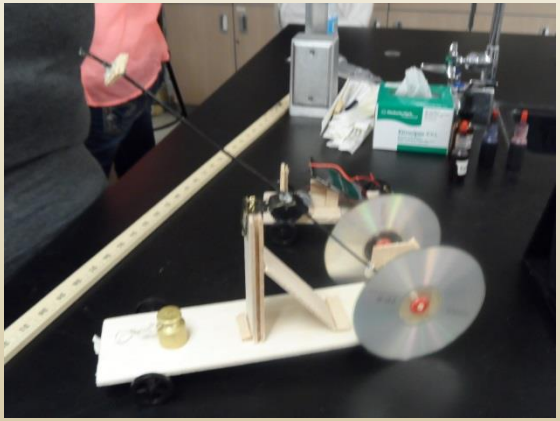
Credit: NASA Scientific Visualization Studio

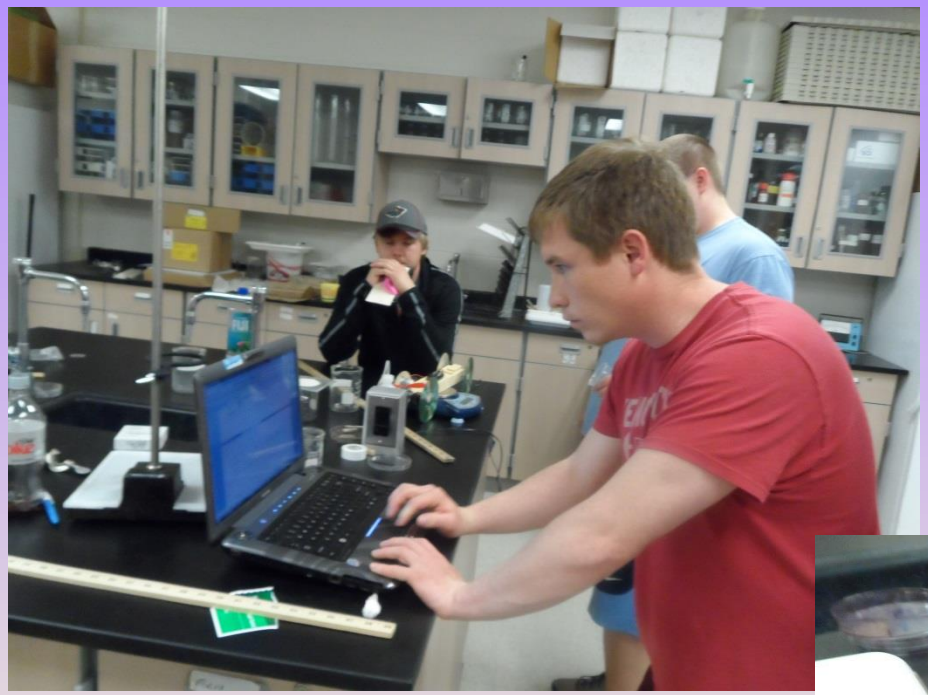
move the slider below to view changes over time

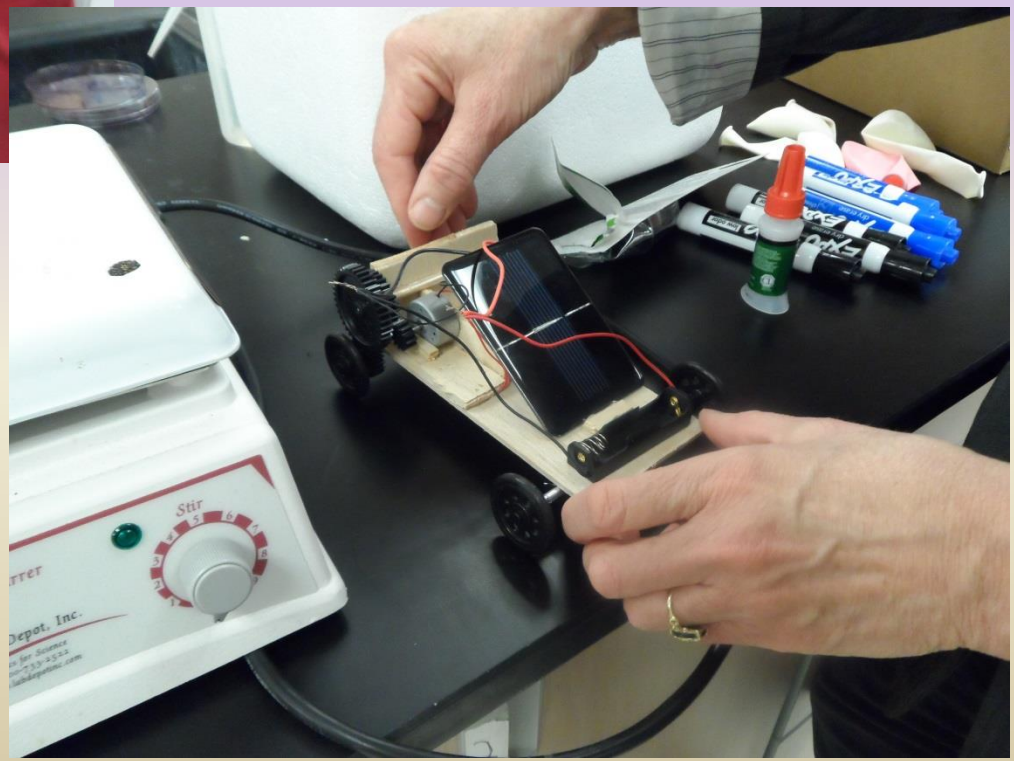


Labs:
1. Combustion enthalpies of various fossil fuels
2. Efficiency of alternative energy choices








Stir

Ice and Remote Sensing

- Paleoclimate and possible causes for fluctuation; the role of positive and negative feedback
- Ice cap and glacier formation as a marker for climate change through earth's history; interpretation of geological formations
- Ice melt, sea level rise, effects on ocean currents
- Phase behavior of water, mp and bp, heat of fusion and energy release
- Albedo and Arctic effect

Laboratory activities:

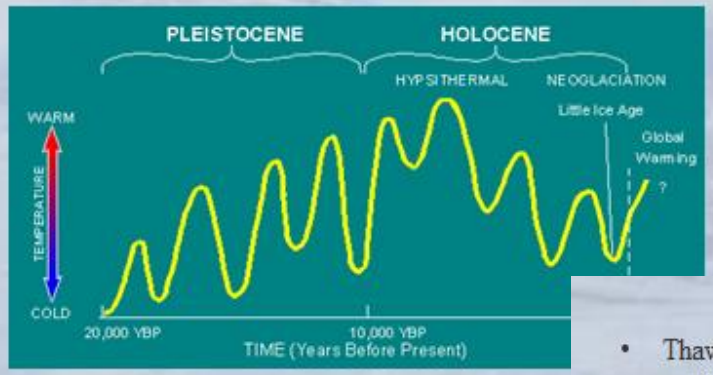
- Archimedes' principle, calculating density of ice;
- Calculating heat of fusion; noting "sea level rise"
- Demo of freshwater and saltwater density

NASA datasets and applications:

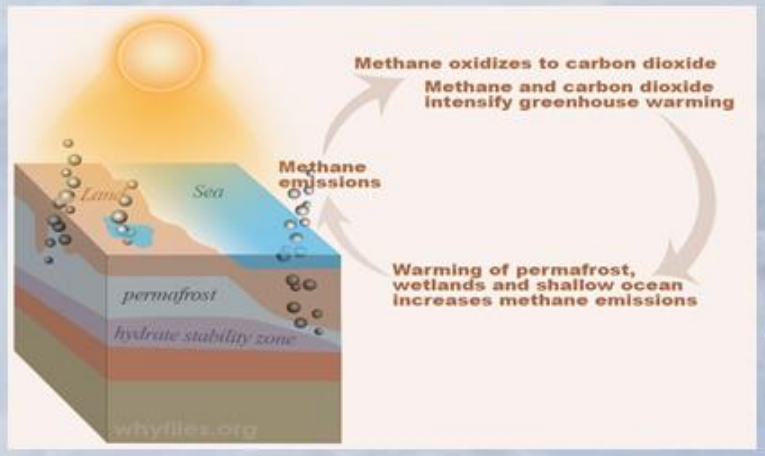
RADARSAT, NASA images of icebergs, glacier shrinkage, calving
Sea level change applications; ocean current images
Polar vortex animations

Earth's Paleoclimate PP

- Right now we are in an ice age that started about 2.6 million years ago and the last glaciation ended 10,000 years ago.
- We are now in an interglacial period that may end soon or not- some scientists predict that glaciation may be delayed by as much as 500,000 years by recent global warming events (Archer, Ganopolski, 2005).



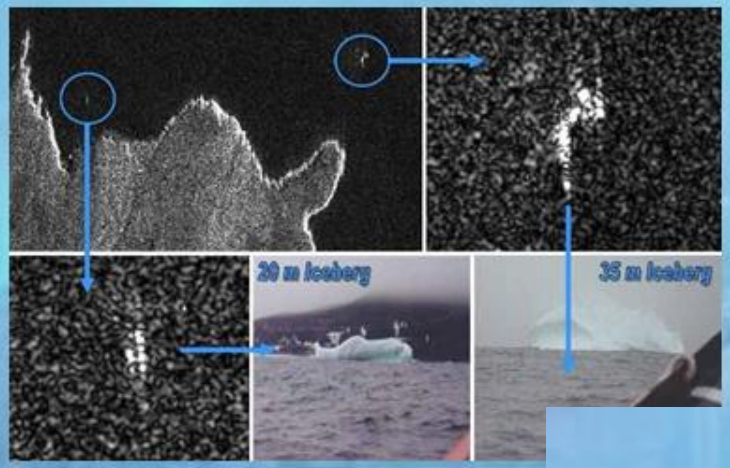
- Thawing of ice and soil causes the release of trapped gases, particularly CO_2 and methane due to gas expansion with heat and release of pressure on soil layers
- The increased greenhouse gas concentrations will raise melt rates even more.



Whyfiles.org

Ice and Remote Sensing PP

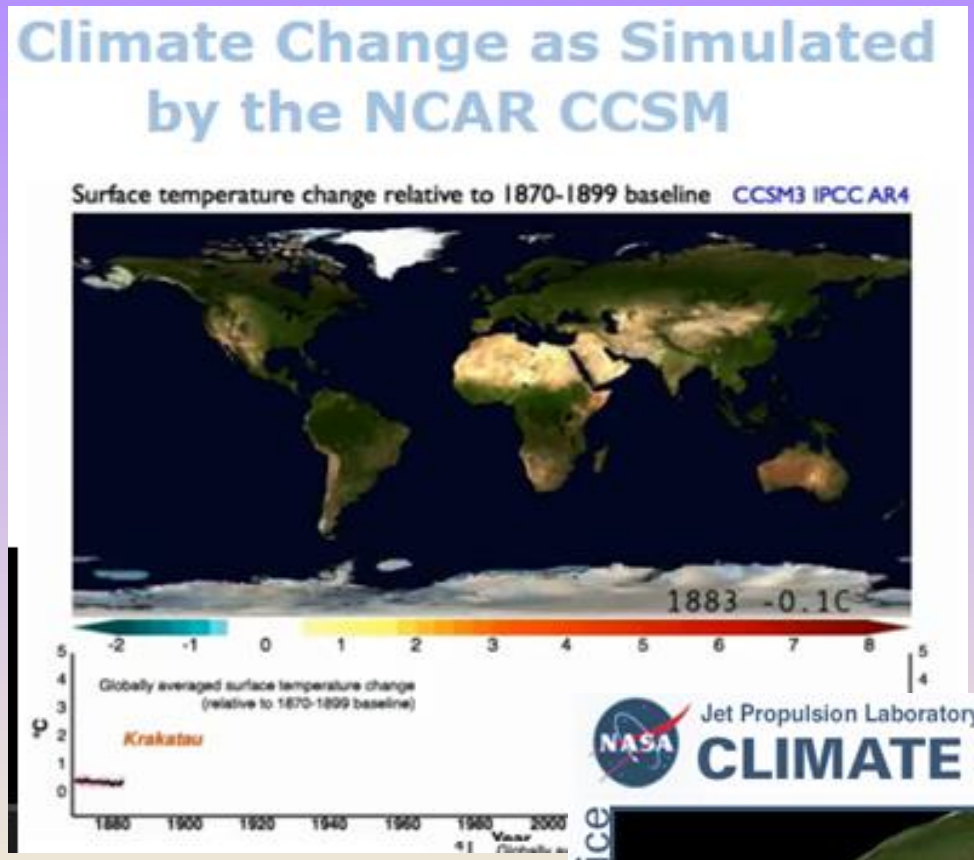
- Canadian remote sensing satellites: RadarSat 1- launched 1995 and RadarSat 2- launched 2007
- Used for ice monitoring but also land use, agriculture, defense, mineralogy
- Both use SAR (synthetic aperature radar) and emit microwave at 5.6 cm wavelength and record reflection
- RadarSat 2 has 1-m resolution and various polarization modes



Precision RADARSAT-1 image with close-ups and visual comparisons. www.icebergfinder.com

- In the context of a raised temperature anomaly (0.4 to 0.6) in recent years compared to the usual interglacial high of 0.2 to 0.3, scientists have sought out the physical evidence of disappearing ice:

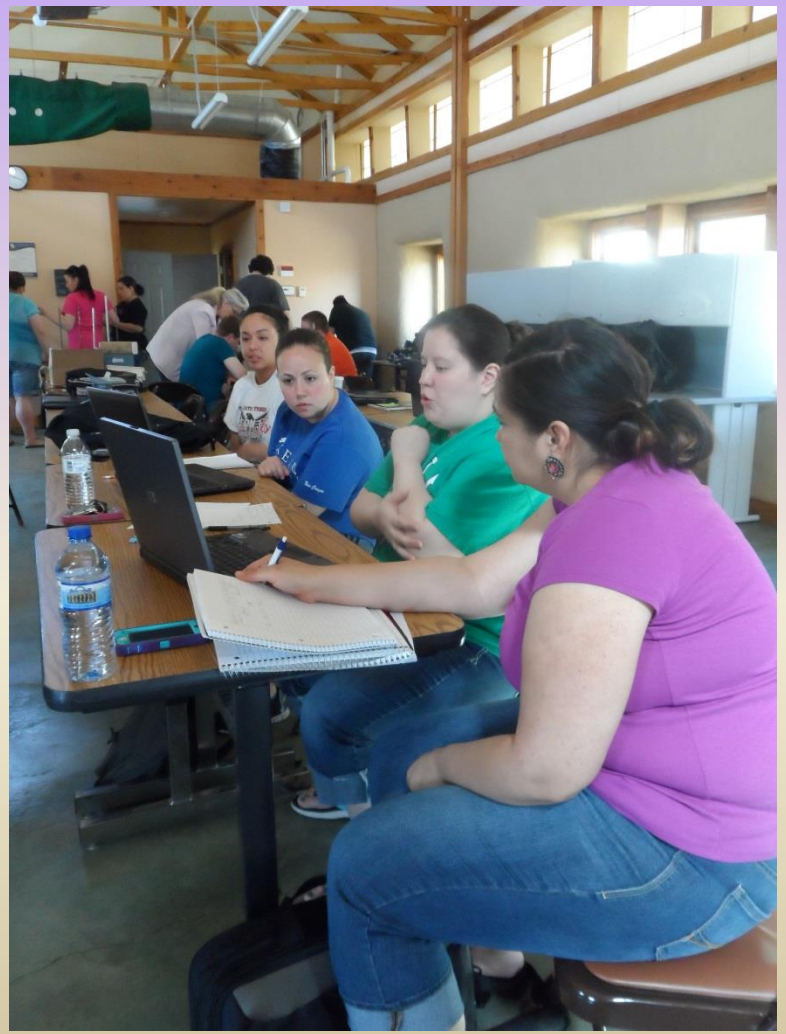
Columbia glacier (Alaska) retreat from 1986 to 2005. NASA LandSat image.



Datasets and Tutorials

Labs: 1. Density of ice
Iceberg melt and ocean level
Meltwater and effects on salinity

2. Heat of fusion



Deforestation, Desertification and Detection PP

Deforestation and Climate

Causing Climate Change:

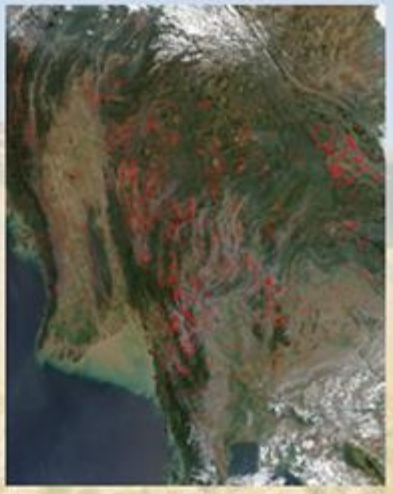
- Fewer trees- less uptake of CO_2 (and less production of O_2)
- CO_2 free to absorb heat and bring up temperatures
- Change in evapotranspiration/humidity patterns- leading to deserts?

Climate change leading to deforestation:

- Higher temperatures- soil more marginal- farmers need to move on
- Larger and more intense weather scenarios of drought and flood- also causing farmers to relocate

Monitoring of Slash and Burn Agriculture

This NASA satellite image shows hundreds of fires burning near the Yucatan peninsula on April 20, 2003. Credit: NASA (MODIS)



Agricultural burning in Indochina (centered on Thailand), where The gray is smoke. Fires are also in Myanmar, Laos Viet Nam and southern China. modis.gsfc.nasa.gov/gallery/

Sedimentation PP

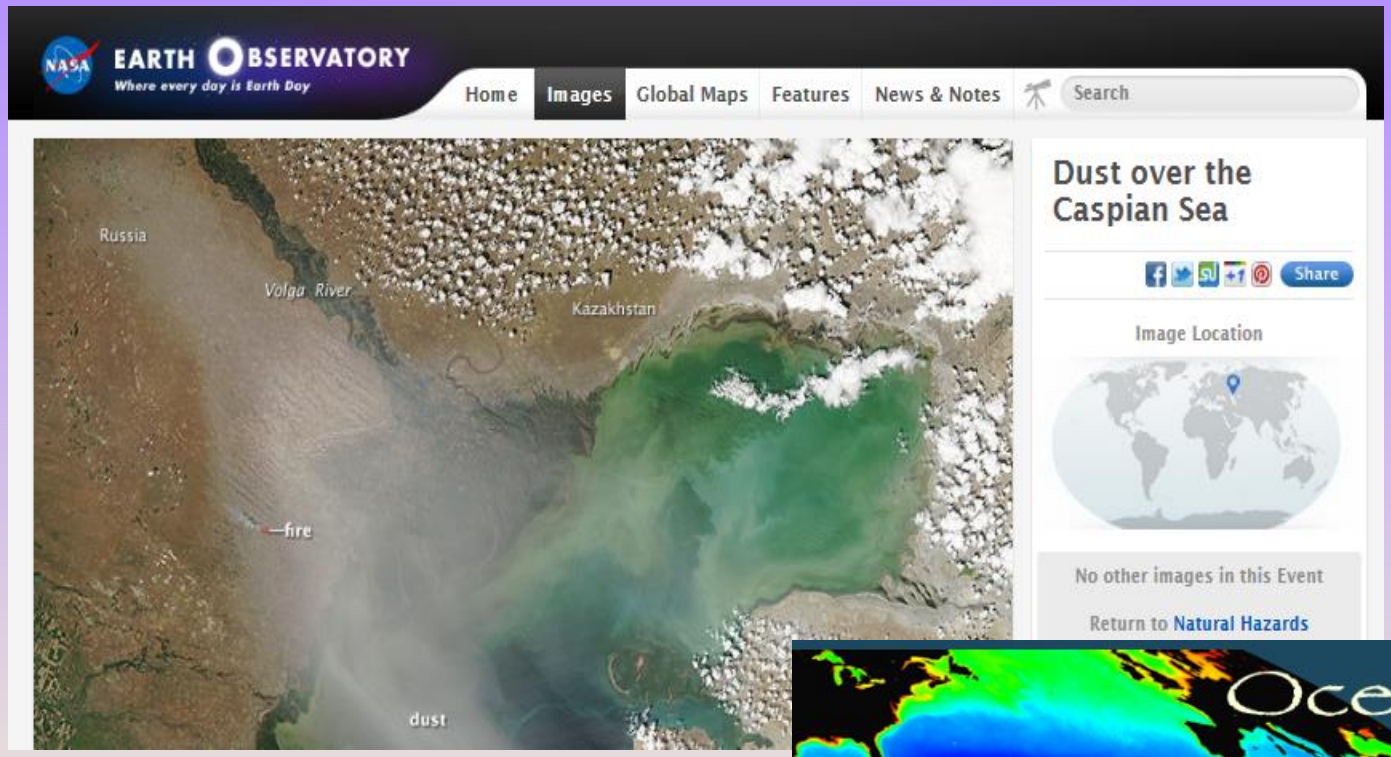
Sources of Erosion by Continent

area	deforestation	fuelwood	overgrazing	agriculture	industrialisation
Europe	35	-	25	29	9
Africa	14	13	49	24	-
North America	4	-	50	66	-
Central America	22	18	15	45	-
South America	41	5	28	26	-
Asia	40	6	26	27	-
Oceania	12	-	50	8	-
World	30	7	35	28	1

Causes of erosion by percent. Source: World Resources Institute, 1990. & L
Oldeman et al, Wageningen, Holland, 1990

Left: A large sediment plume enters the Mozambique Channel south of the resort town of Beira. (Satellite photo courtesy NASA)

Right: SeaWIFS image: Gulf Coast, mouth of Mississippi "Visible Earth" website

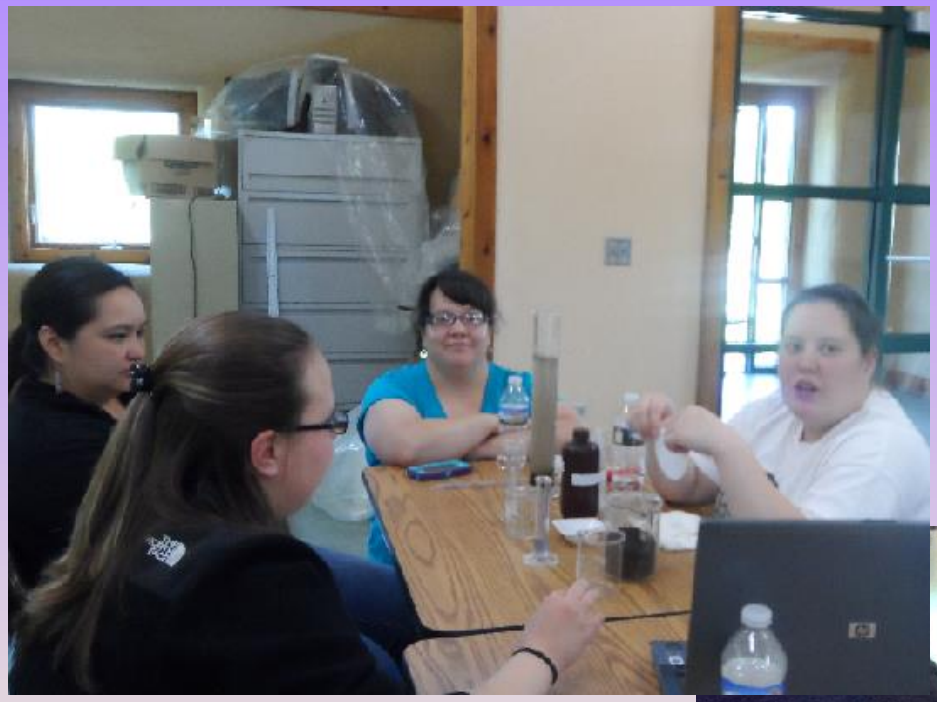


Datasets and Tutorials

Labs:

1. Finding texture of soil by Buoyocos method

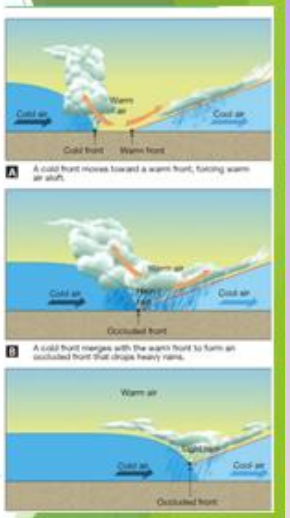
2. Infiltration, permeability and runoff properties of clay vs sand
3. Allan Savory video/ student thoughts on desertification



Weather Basics and Local Effects

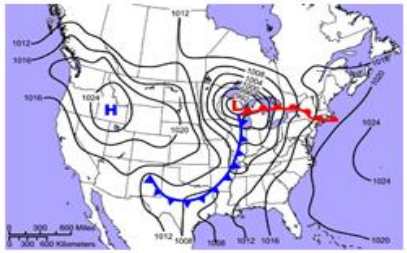
Stationary and Occluded Fronts

- An **occluded front** or **occlusion** usually forms around a low pressure system.
  - The occlusion starts when a cold front catches up to a warm front. The air masses, in order from front to back, are cold, warm, and then cold again.

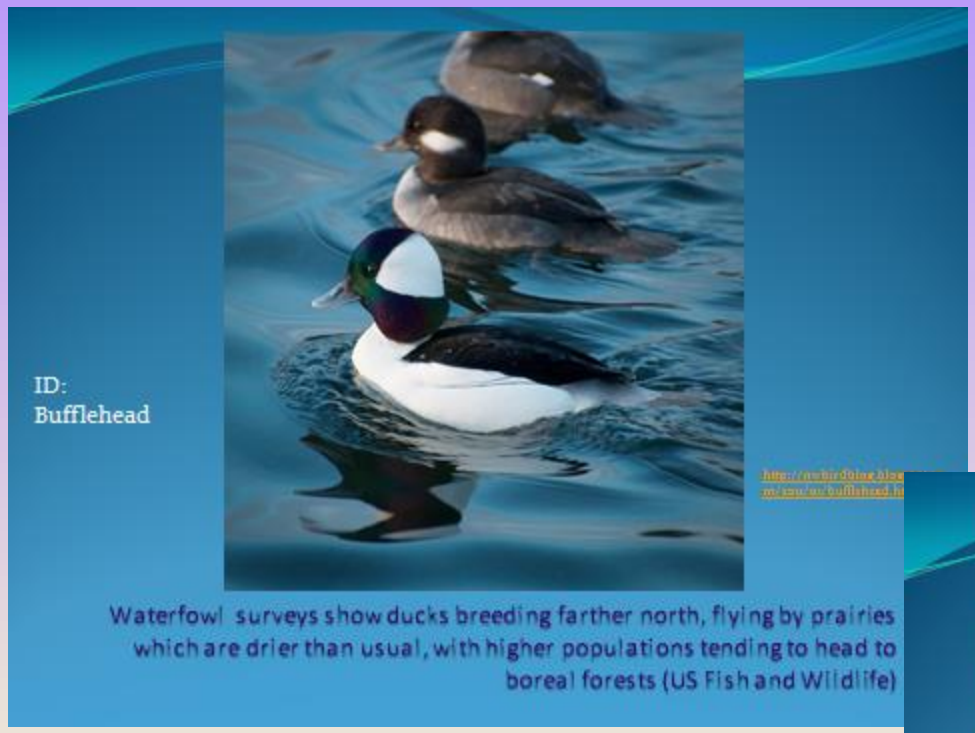


Mapping Exercise

- Analyze a surface weather map for temperature, and draw the cold and warm fronts that are represented by temperature.
- HINT: Think about the change between seasons.



Datasets and Tutorials



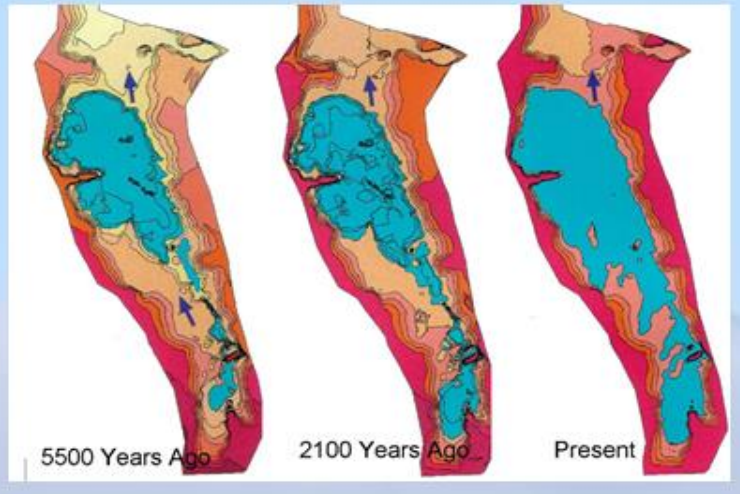
Labs:

1. Plant/waterfowl ID of local area
2. Trends in Willow City weather data and
   Phenology tour- when plants are blooming compared to past

Seismic Events and Climate Change PP

Isostatic rebound concern:

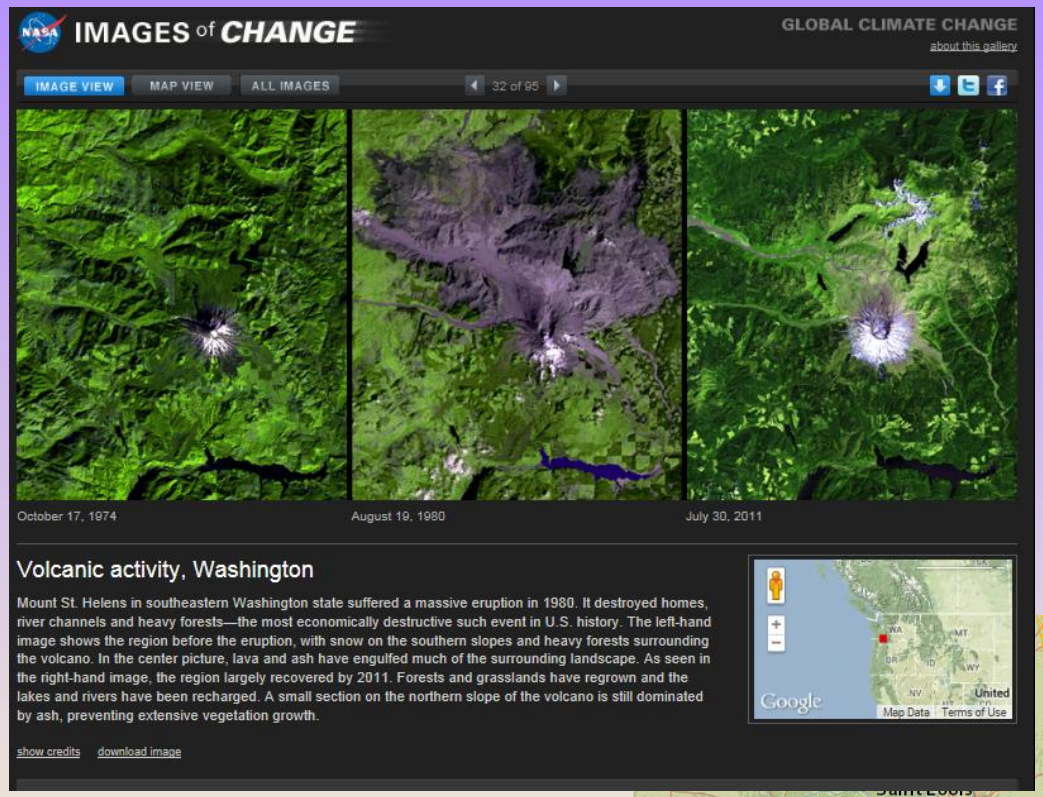
- What it is: The raising of land surface after weight is removed, particularly ice due to ice melt
- Considered to possibly be a dangerous event near areas of fault lines, volcanoes or other magmatic activity
- Faults and magma chambers which are stable under a regime of tremendous weight may become unstable and active, allowing slippages (earthquakes) and allowing magma to gain volume under less pressure.
- The latter case would lead to increased rock melt and possible release of magma from a chamber that has become too constrictive.

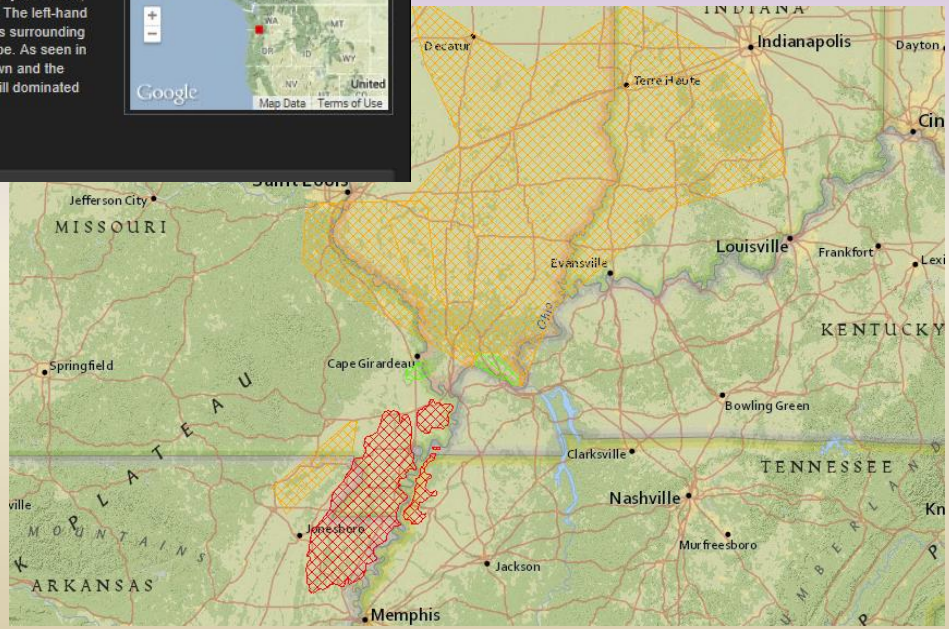


Lake Winnipeg tilting up at North due to rebound (red); water flows to south end

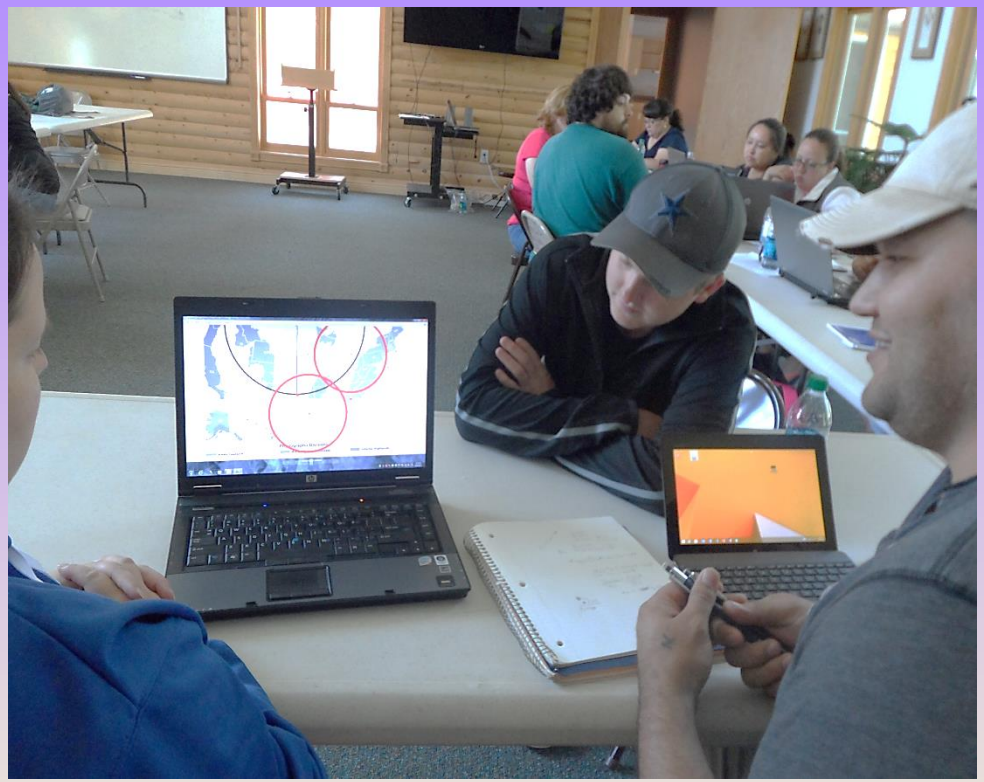
https://www.hydro.mb.ca/corporate/water_regimes/lake_wpg_facts_fiction.shtml

Datasets and Tutorials

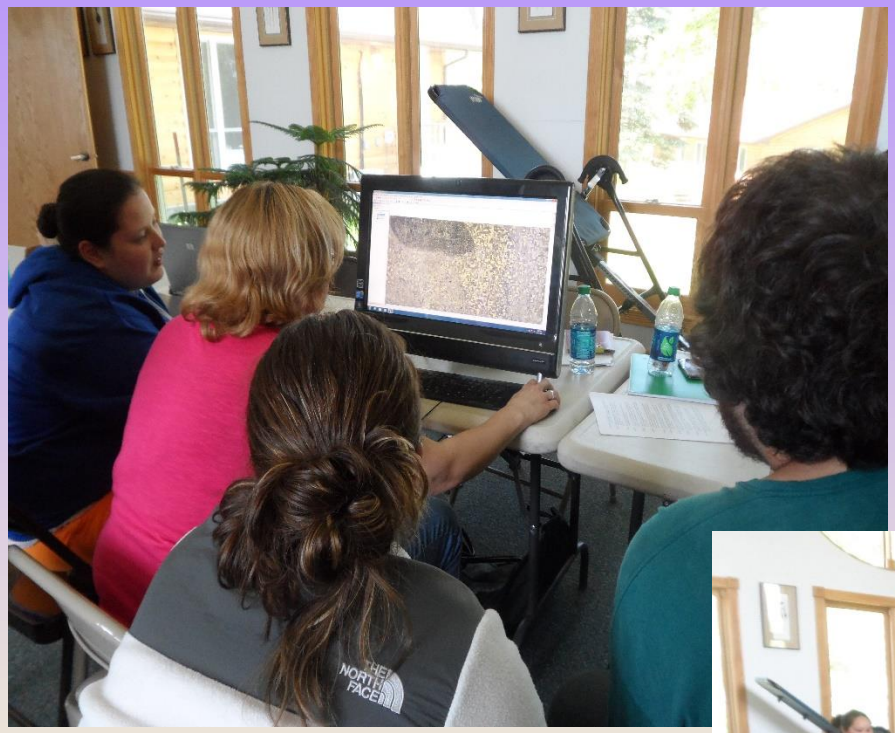




http://earthquake.usgs.gov/hazards/qfaults/map/



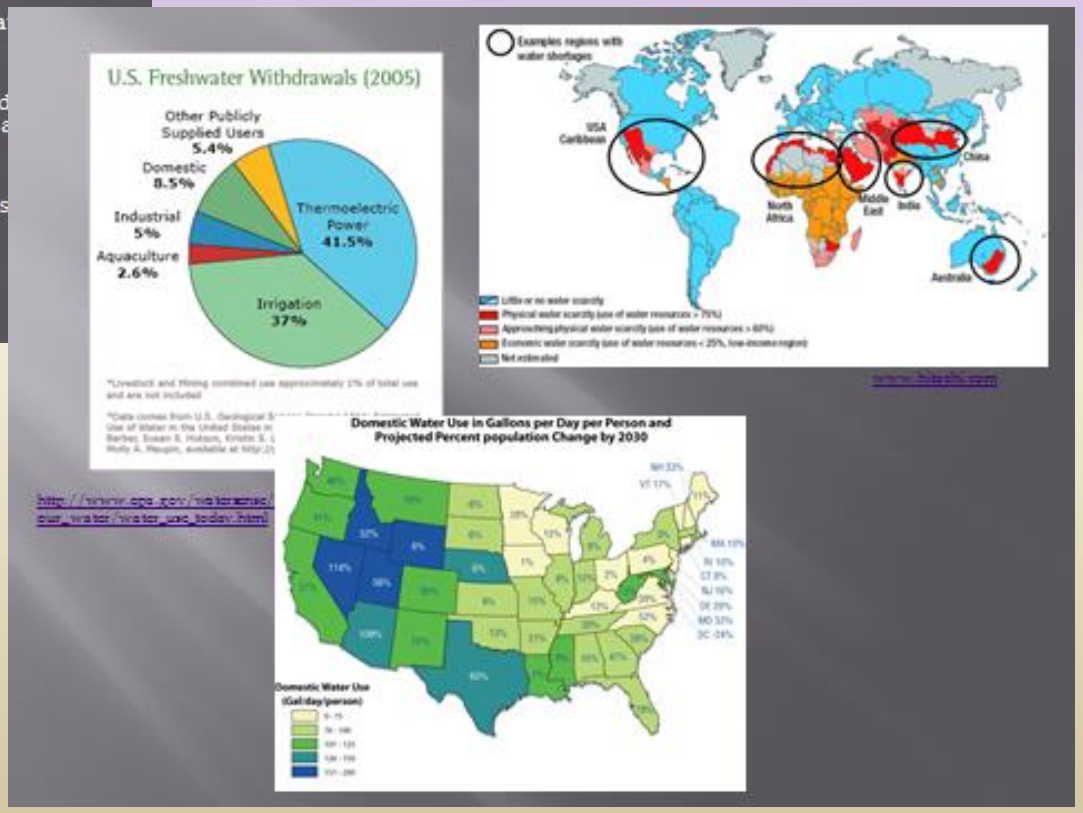
Labs:
1. Pressure reduction effects (magma)
2. Force of moving rock
3. Triangulation/Quake epicenter
4. GIS- land use (ND USGS)

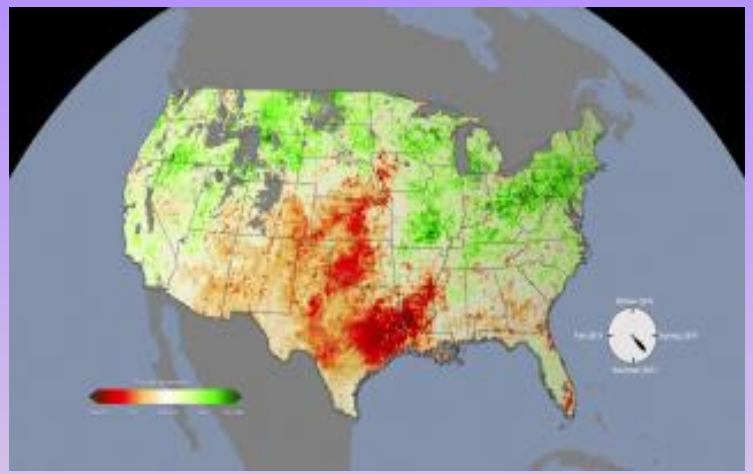

THE NORTH FACE

Drought, Flood and Fire

Water Crisis

- Water is a "limited renewable resource;" it moves through the hydrologic cycle, but is the same material that was here billions of years ago
- Freshwater in lakes and rivers is 2.5% of all water on earth (96.5% is saltwater and another 1% is freshwater frozen in glaciers)
- The average American uses 100 gallons of water a day- 36 sta projected shortages in 2013
- Groundwater depletion is an ongoing problem in the US (and elsewhere)- aquifers supply 50% of total drinking water and a portion (50 billion gallons) of the water used for agriculture
- Major aquifers, such as the Ogallala (which spans eight states seen decreases of 50-400 cubic kilometers since 1900

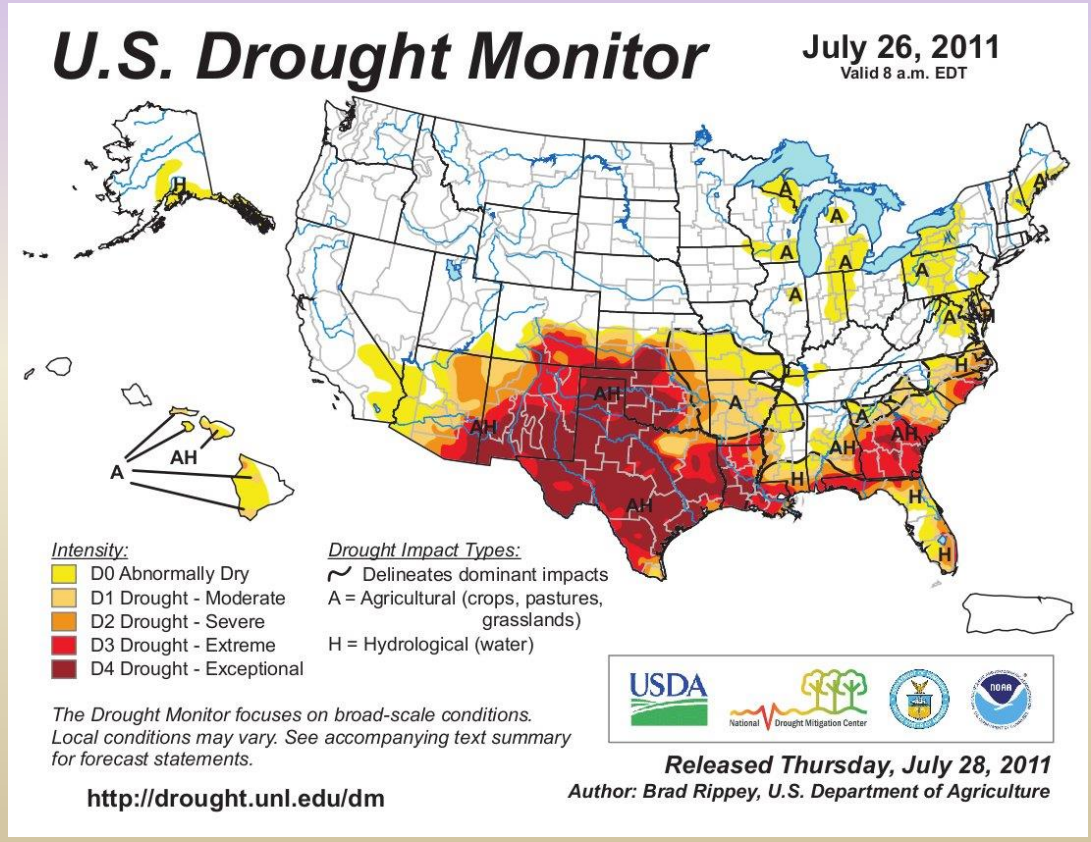




Video on drought 2010- 2012:
http://svs.gsfc.nasa.gov/vis/a000000/a004000/a004015/index.html

Datasets and Tutorials

U.S. Drought Monitor- updated daily (date here is random)



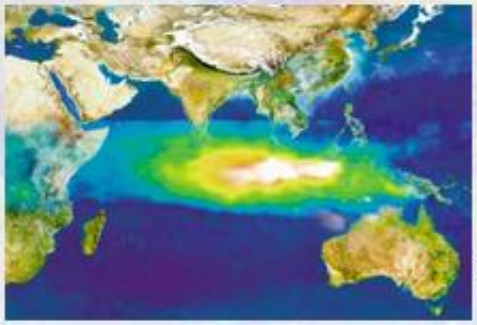
Labs:

1. Drought video/student thoughts on mitigation
2. Local secondary succession (post-tornado)
3. Local flooding effects (Ox Creek)

Pollution and Climate Change

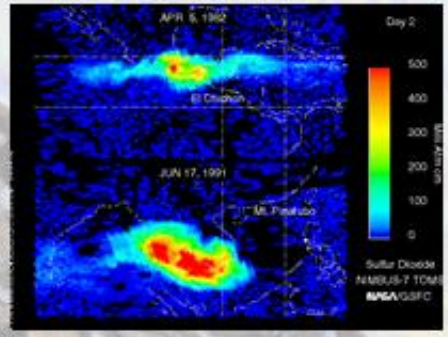
Pollution and Remote Sensing

- Satellite monitoring of specific pollutants is a job shared with airplane sensors. The ERS2 satellite flies with the GOME sensor (Global **Ozone** Monitoring Experiment) with four bands that vary from 0.24 tp 0.79 microns (UV to visible)
- On board the Terra satellite is the MOPITT sensor (Measurement Of Pollution In The Troposphere) which detects CH_3 at 2.3 microns (IR) and CO at 2.4 and 4.7 microns (IR)
- The TOMS (Total Ozone Mapping Spectrometer) instrument aboard the Earthprobe/TOMS satellite (and others in the past) measure **ozone** in a vertical column of the atmosphere by sensing UV backscatter from the atmosphere. The instrument also senses **particulate matter** (fires, dust storms) and S
- The UARS (Upper Atmosphere Research Satellite carries several inst measure trace gases in the the stratosphere and mesosphere.

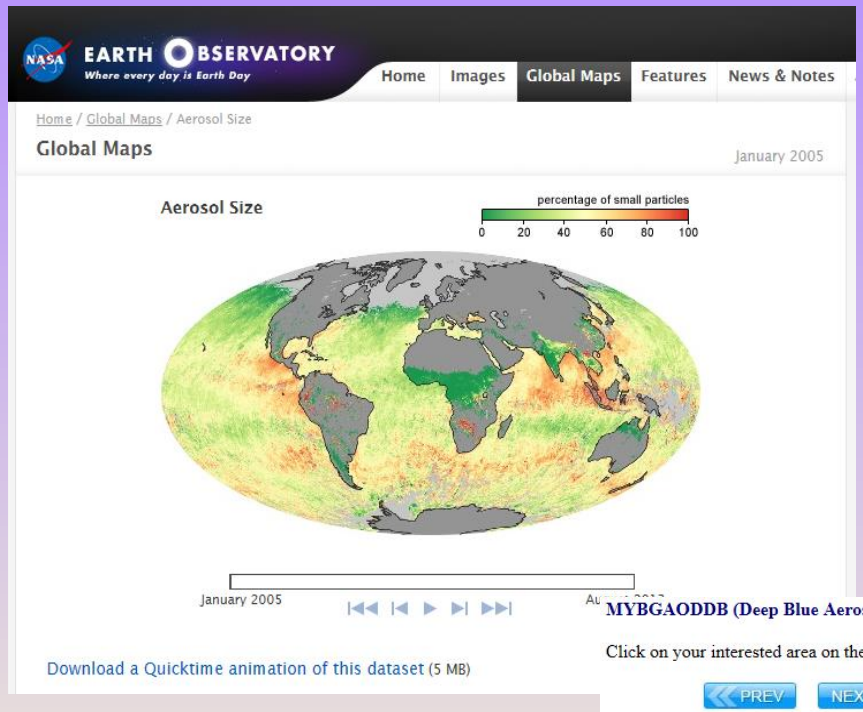


Courtesy NYtimes.com

Smog and smoke plumes in Indonesia in 1997 were monitored by satellite and found to have different flow rates and patterns



TOMS images of SO_2 levels after the 1982 eruption of the Mexican volcano El Chichon and the 1991 eruption of Mt. Pinatubo in the Philippines. Courtesy NASA

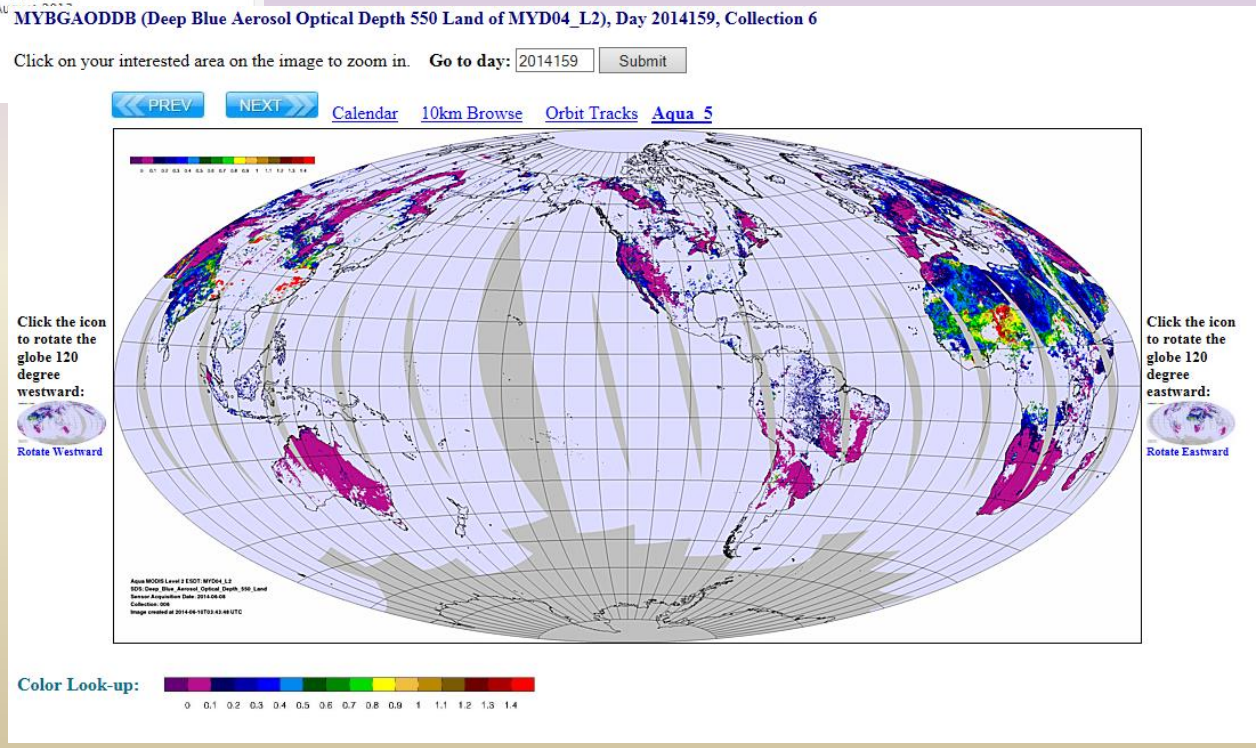


Images of detected aerosols and other pollutants

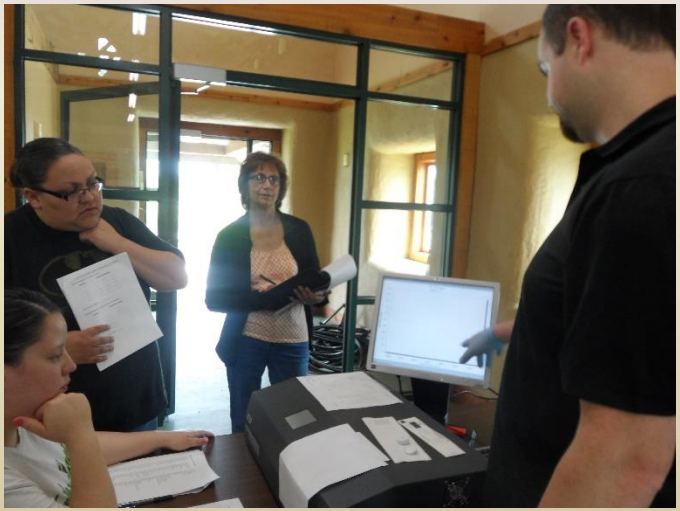
http://earthobservatory.nasa.gov/GlobalMaps/view.php?d1=MODAL2_M_AER_RA

Aerosol depth over land

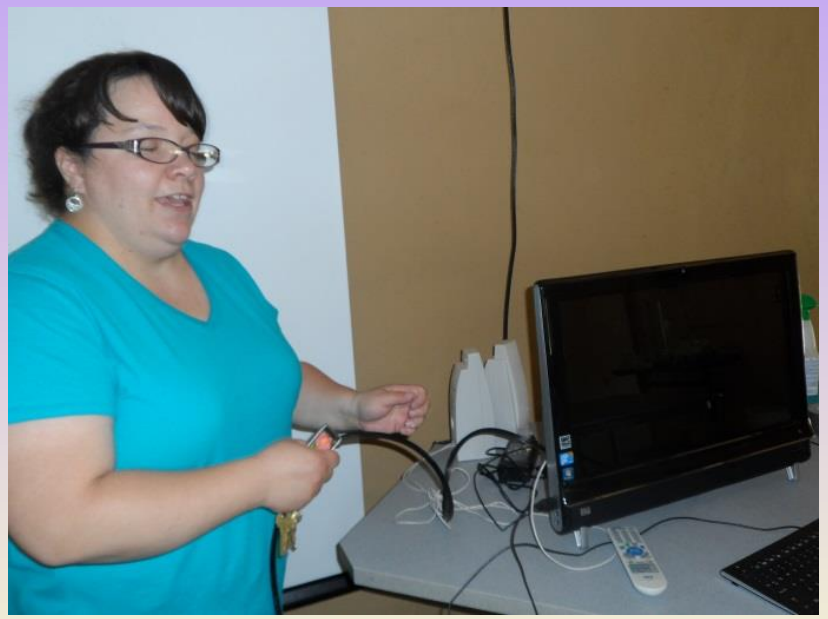
http://modis-atmos.gsfc.nasa.gov/IMAGES/index.html



Labs:
1. Air pollutant detection and ID by IR and UV/VIS (assisted by UND graduate students)
2. Macroinvertebrates as pollution indicators




ANISHINABE LEARNING
CULTURAL & WELLNESS CENTER



Challenges

- Anishinabe Wellness Center had poor router capabilities- all 20 students had trouble logging onto notes at the same time and GIS was painfully slow.

- Several of the laboratories need to be modified- usually a matter of details, like ordering a different solar panel car, and using more sophisticated calorimeters.

- Several students who wanted to get course credit did not have the money to pay for the course (PELL for that year was gone).

Change of Plan Challenges

- Modifying lesson plans for elementary did not happen due to time constraint; however, students said plans were easily adapted to elementary or secondary benchmarks and difficulty level.

- Instead of educational people on board every year, one year was sufficient- can we use the salary for GCCE experts, Native American speakers, more cultural input, etc?

- We would like to offer course credit next year to public school teachers – does it have to be over 400 level and are we able to do this at the community college?

Plan of Action

- Updating laboratories, researching other possibilities- no problem
- Asking pointed questions of admin in terms of updating wellness center for better IT- will look at money sources
- Will ask NASA about re-assignment of education department role

- Will talk to admin and DPI about the possibility of conducting a course for teachers
- May have to look at alternative funding for students in third year of grant who want to take the course and need monetary help
- Will plan on keeping lesson plans general so that students and teachers can modify at their own discretion- seems to be popular